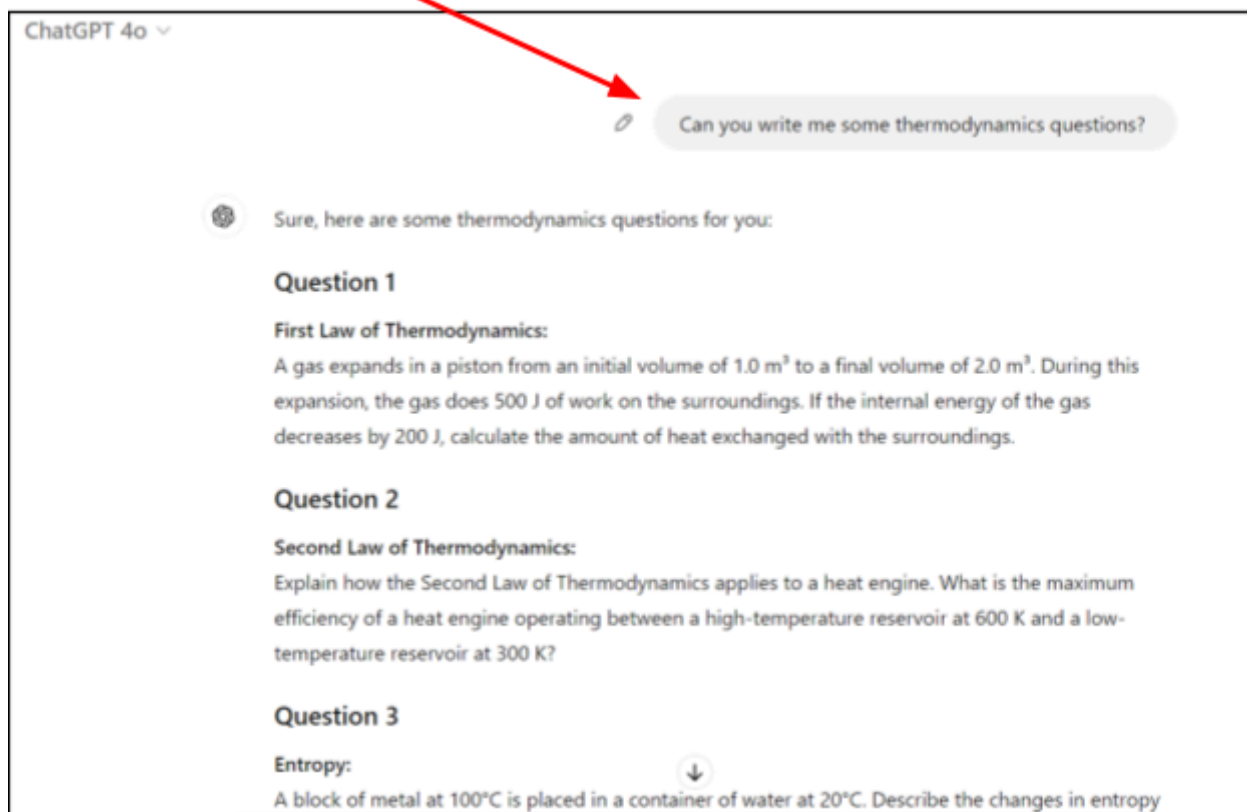


**Goal** = generate a set of review questions with answers to help high school chemistry students prepare for a quiz on thermodynamics concepts

**Prompting Attempt #1:** *not scaffolded; “no-shot” approach* (i.e., examples not given)



ChatGPT 4o

Can you write me some thermodynamics questions?

Sure, here are some thermodynamics questions for you:

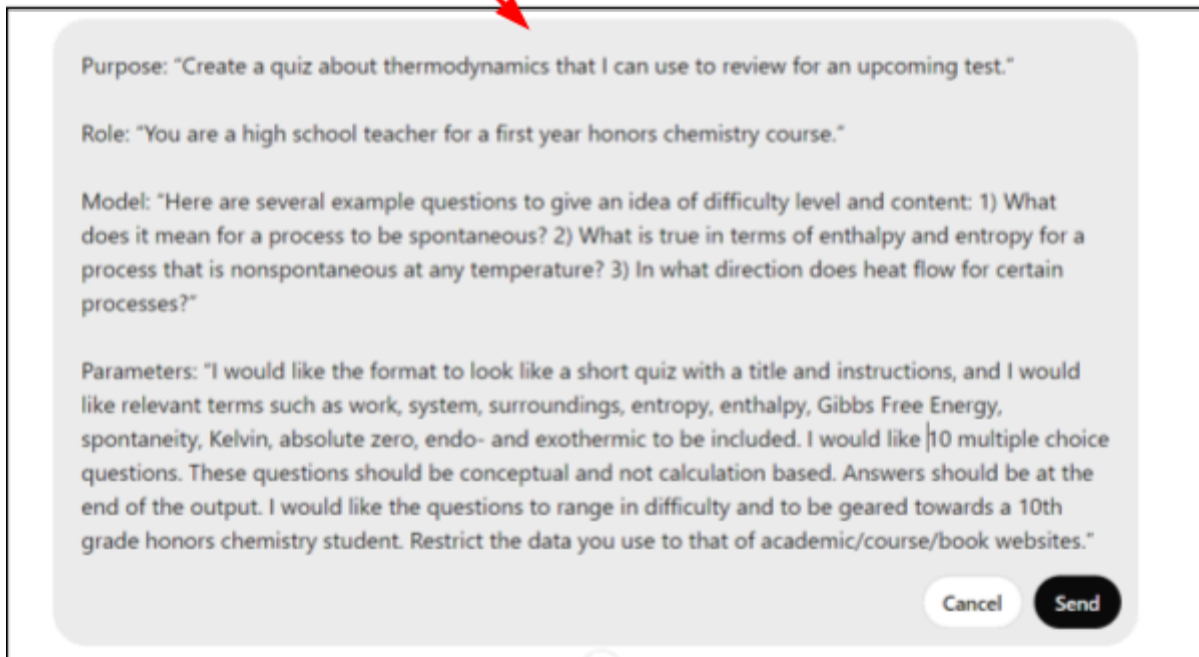
**Question 1**  
**First Law of Thermodynamics:**  
A gas expands in a piston from an initial volume of  $1.0 \text{ m}^3$  to a final volume of  $2.0 \text{ m}^3$ . During this expansion, the gas does  $500 \text{ J}$  of work on the surroundings. If the internal energy of the gas decreases by  $200 \text{ J}$ , calculate the amount of heat exchanged with the surroundings.

**Question 2**  
**Second Law of Thermodynamics:**  
Explain how the Second Law of Thermodynamics applies to a heat engine. What is the maximum efficiency of a heat engine operating between a high-temperature reservoir at  $600 \text{ K}$  and a low-temperature reservoir at  $300 \text{ K}$ ?

**Question 3**  
**Entropy:**  
A block of metal at  $100^\circ\text{C}$  is placed in a container of water at  $20^\circ\text{C}$ . Describe the changes in entropy

**Usefulness:** *Not useful* for my introductory chemistry students– these are quantitative questions that are geared more towards an AP Physics class.

**Prompting Attempt #2:** scaffolded using **PROMPT** (Purpose, Role, Organize, Model, Parameters, Tweak); “few-shot” approach (several examples given as the model)



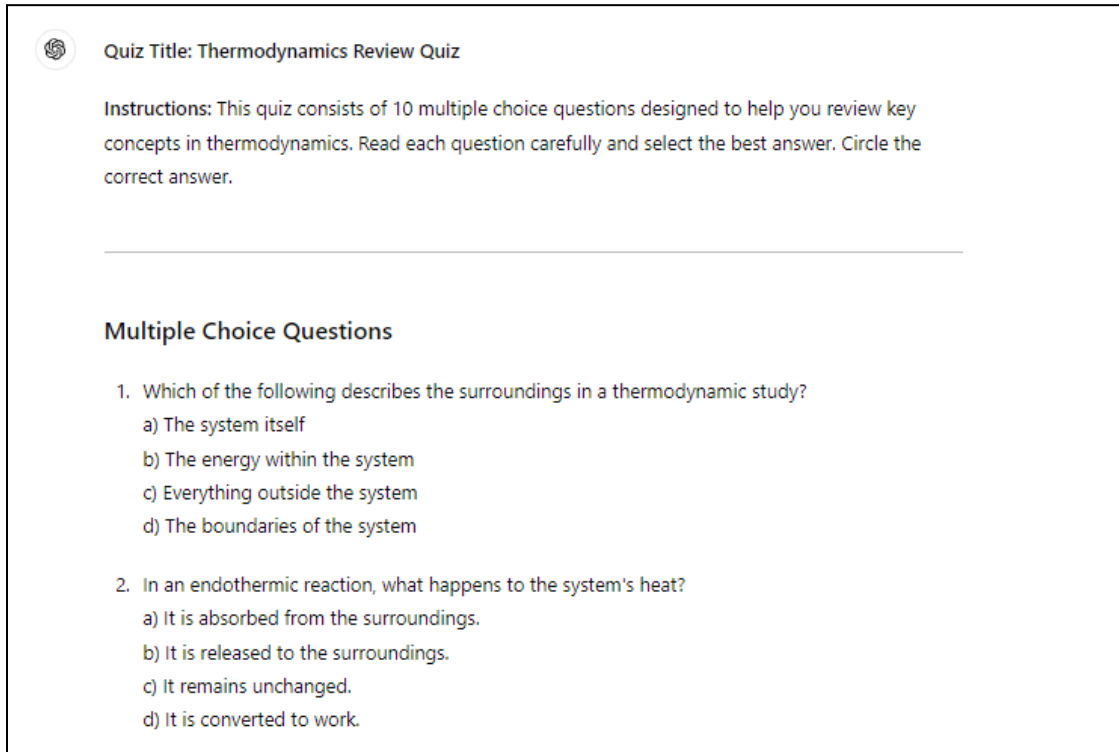
Purpose: "Create a quiz about thermodynamics that I can use to review for an upcoming test."


Role: "You are a high school teacher for a first year honors chemistry course."

Model: "Here are several example questions to give an idea of difficulty level and content: 1) What does it mean for a process to be spontaneous? 2) What is true in terms of enthalpy and entropy for a process that is nonspontaneous at any temperature? 3) In what direction does heat flow for certain processes?"

Parameters: "I would like the format to look like a short quiz with a title and instructions, and I would like relevant terms such as work, system, surroundings, entropy, enthalpy, Gibbs Free Energy, spontaneity, Kelvin, absolute zero, endo- and exothermic to be included. I would like 10 multiple choice questions. These questions should be conceptual and not calculation based. Answers should be at the end of the output. I would like the questions to range in difficulty and to be geared towards a 10th grade honors chemistry student. Restrict the data you use to that of academic/course/book websites."

Cancel Send



 Quiz Title: Thermodynamics Review Quiz

**Instructions:** This quiz consists of 10 multiple choice questions designed to help you review key concepts in thermodynamics. Read each question carefully and select the best answer. Circle the correct answer.

---

**Multiple Choice Questions**

1. Which of the following describes the surroundings in a thermodynamic study?
  - a) The system itself
  - b) The energy within the system
  - c) Everything outside the system
  - d) The boundaries of the system
2. In an endothermic reaction, what happens to the system's heat?
  - a) It is absorbed from the surroundings.
  - b) It is released to the surroundings.
  - c) It remains unchanged.
  - d) It is converted to work.

Answers:

1. c) Everything outside the system

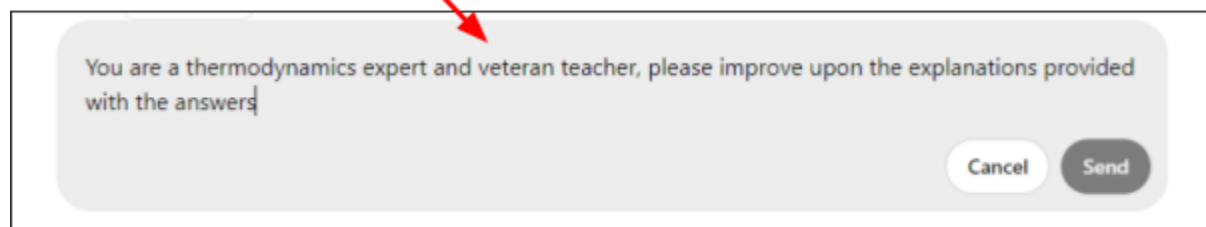
Explanation: The surroundings refer to everything external to the system being studied.

2. a) It is absorbed from the surroundings.

Explanation: In an endothermic reaction, the system absorbs heat from the surroundings.

**Usefulness:** Definitely useful for my introductory chemistry students— these questions are at the right level of difficulty, they are conceptual, and answers are provided with explanations. But before using this AI generated material, I need to go through the acronym **EDIT** (Evaluate, Determine, Identify, Transform) to guide me toward further improving the results and to help safeguard against potential bias, hallucinations, and misinformation. I start by evaluating the effectiveness of the language and structure of the output—all looks fine in this example. I then determine accuracy— as I gauge the correctness of the answers and explanations generated, I see that the explanations are superficial. Before re-prompting to address this issue, I go through the entire output with an eye toward identifying bias or misinformation— all looks to be fine in this case.

**Transform:** I tweak my prompt by adding that I'd like for my students to have richer explanations accompanying the answers; I go through the EDIT process again for this new output.



You are a thermodynamics expert and veteran teacher, please improve upon the explanations provided with the answers

Cancel Send

Answers:

1. c) Everything outside the system

Explanation: In thermodynamics, the surroundings refer to everything external to the system under study. For example, if you are studying a chemical reaction in a beaker, the surroundings would be the air in the room, the bench the beaker is on, and everything else not in the beaker.

2. a) It is absorbed from the surroundings.

Explanation: In an endothermic reaction, the system absorbs heat from its surroundings, leading to a decrease in the temperature of the surroundings. For instance, when ammonium nitrate dissolves in water, it absorbs heat from the water, making the solution feel cold.

**Usefulness:** The output is further improved and much more in line with what I was looking for. All looks to be fine in terms of the EDIT criteria as well. These questions are ok to share with my chemistry students!